Docket No. 202462-US2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: Tomohiro NAKAJIMA et al.

SERIAL NO: 09/769,510 GAU: 2876

FILED: January 26, 2001 EXAMINER: PAIK, S. S.

FOR: OPTICAL SCAN MODULE, OPTICAL SCANNER, OPTICAL SCAN METHOD, IMAGE GENERATOR AND IMAGE READER

INFORMATION DISCLOSURE STATEMENT UNDER 37 CFR 1.97

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

SIR:

Applicant(s) wish to disclose the following information.

REFERENCES

☐ The applicant(s) wish to make of record the references listed on the attached form PTO-1449. Copies of the listed references are attached, where required, as are either statements of relevancy or any readily available English translations of pertinent portions of any non-English language references.

☐ A check is attached in the amount required under 37 CFR §1.17(p).

RELATED CASES

■ Attached is a list of applicant's pending application(s) which may be related to the present application. A copy of the claims and drawings of the pending application(s) is attached.

☐ A check is attached in the amount required under 37 CFR §1.17(p).

CERTIFICATION

☐ Each item of information contained in this information disclosure statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement.

■ No item of information contained in this information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application or, to the knowledge of the undersigned, having made reasonable inquiry, was known to any individual designated in 37 CFR §1.56(c) more than three months prior to the filing of this statement.

DEPOSIT ACCOUNT

■ Please charge any additional fees for the papers being filed herewith and for which no check is enclosed herewith, or credit any overpayment to deposit account number 15-0030. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

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LIST OF RELATED CASES

Docket Number	Serial or Patent Number	Filing or Issue Date	Inventor/ Applicant
202462US2*	09/769,510	01/26/01	NAKAJIMA et al.
235228US2	10/386,654	03/13/03	AMADA et al.

*Present Application; listed for information
GJM/sb
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WHAT IS CLAIMED IS:

1. An optical scanning apparatus for scanning a surface to be scanned in a main scanning direction by simultaneously using a plurality of optical spots formed of a plurality of optical beams emitted from an illuminant, comprising:

a light path deflecting part deflecting a light path of at least one of said optical beams,

wherein said light path deflecting part is provided in light paths of said optical beams.

2. The optical scanning apparatus as claimed in claim 1, wherein said light path deflecting part uses a liquid crystal deflecting element formed of a liquid crystal element being controllable by an electronic signal to deflect the light path of said one of the optical beams.

3. The optical scanning apparatus as claimed in claim 2, wherein said liquid crystal deflecting element is capable of deflecting optical beams separately in two directions orthogonal to each other.

4. The optical scanning apparatus as claimed in claim 2, wherein said liquid crystal deflecting element has a plurality of effective areas each of which is separately modulated.

5. The optical scanning apparatus as claimed in claim 2, wherein said illuminant comprises at least a semiconductor laser serving as an illuminant point and a coupling lens coupling laser light emitted from said semiconductor laser.

6. The optical scanning apparatus as claimed in claim 2, further comprising a beam synthesizing part synthesizing optical beams emitted from a plurality of illuminants.

7. The optical scanning apparatus as claimed in claim 6, wherein each of said illuminants comprises at least a semiconductor laser serving as an illuminant point and a coupling lens coupling laser light emitted from said semiconductor laser, and said semiconductor and said coupling lens are arranged so as to correct a synthesis error by said beam synthesizing part.

8. The optical scanning apparatus as claimed in claim 2, further comprising an aperture member having an aperture for shaping an optical beam wherein said

aperture member is provided in an upper stream side, that is, in an illuminant side, of the liquid crystal deflecting element in the light paths of the optical beams.

9. The optical scanning apparatus as claimed in claim 8, wherein said aperture for shaping an optical beam is formed on one of an entrance surface and an exit surface of said liquid crystal deflecting element.

10. The optical scanning apparatus as claimed in claim 2, further comprising a detecting part detecting positions of said optical spots for simultaneously scanning said surface to be scanned and a driving part driving/controlling a liquid crystal deflecting element based on a detection result of said detecting part so as to adjust a position of at least one of said optical spots.

11. An illuminant apparatus for emitting a plurality of optical beams and serving an optical scanning apparatus for scanning a surface to be scanned in a main scanning direction by simultaneously using a plurality of optical spots formed of said optical beams emitted from a plurality of illuminants therein, wherein said optical scanning apparatus comprises a light path deflecting part, which is provided in light paths of said optical beams, deflecting a light path of at least one of said optical beams, comprising:

a plurality of light path deflecting parts separately deflecting one of said optical beams corresponding to each of said light path deflecting parts,

wherein said light path deflecting parts are integrally provided.

12. The illuminant apparatus as claimed in claim 11, wherein said light path deflecting part is

formed of a transmission type optical element and is provided in light paths of the optical beams.

13. The illuminant apparatus as claimed in claim 11, wherein said light path deflecting part is formed of a reflection type optical element and is provided in light paths of the optical beams.

14. The illuminant apparatus as claimed in claim 12, wherein said transmission type optical element is driven by a driving part using a piezoelectric element.

15. The illuminant apparatus as claimed in claim 13, wherein said reflection type optical element is driven by a driving part using a piezoelectric

element.

16. The illuminant apparatus as claimed in claim 12, wherein said transmission type optical element is driven by a driving part using one of a pulse motor capable of rotating by a predetermined angle in accordance with an input pulse signal and a pulse motor capable of moving straight by a predetermined distance in accordance with an input pulse signal.

17. The illuminant apparatus as claimed in claim 13, wherein said reflection type optical element is driven by a driving part using one of a pulse motor capable of rotating by a predetermined angle in accordance with an input pulse signal and a pulse motor capable of moving straight by a predetermined distance in accordance with an input pulse signal.

18. The illuminant apparatus as claimed in claim 11, wherein said light path defecting part is formed of a liquid crystal element driven by an electronic signal.

19. The illuminant apparatus as claimed in claim 11, further comprising a first illuminant part integrally having a plurality of illuminants aligned in line in the main scanning direction, a second illuminant part integrally having a plurality of illuminants aligned in line in the main scanning direction, and a beam synthesizing part making optical beams emitted from said first illuminant part and said second illuminant part close to each other and emitting said close optical beams.

20. The illuminant apparatus as claimed in

claim 11, wherein said illuminants comprises a plurality of semiconductor lasers and a plurality of coupling lenses corresponding to said semiconductor lasers.

21. The illuminant apparatus as claimed in claim 11, further comprising an aperture member having an aperture for shaping an optical beam, wherein said aperture member is provided in an upper steam side, that is, an illuminant side, of said light path deflecting parts.

22. An optical scanning apparatus for scanning a surface to be scanned in a main scanning direction by simultaneously using a plurality of optical spots formed of a plurality of optical beams emitted from a plurality of illuminants in an illuminant apparatus wherein said illuminant apparatus comprises a plurality of light path deflecting parts, which is integrally provided therein, deflecting one of said

optical beams corresponding to each of said light path deflecting parts, comprising:

a detecting part detecting positions of said optical spots for simultaneously scanning said surface to be scanned; and

a driving part driving/controlling said light path deflecting parts based on a detection result of said detecting part so as to adjust a position of at least one of said optical spots.

23. The optical scanning apparatus as claimed in claim 22, further comprising a deflector deflecting said optical beams emitted from said illuminants and a scanning type imaging system scanning said surface to be scanned by using said optical spots formed of said optical beams deflected, wherein said optical beams from said illuminants enter said deflector non-parallel with each other with respect to the main scanning section.

24. The optical scanning apparatus as claimed in claim 1, further comprising an illuminant apparatus formed of a plurality of illuminants, a beam synthesizing part synthesizing a plurality of optical beams emitted from said illuminant apparatus, a deflector deflecting said optical beams synthesized by said beam synthesizing part, and a scanning part leading said optical beams deflected by said deflector on said surface to be scanned, wherein said light path deflecting part is provided between said illuminants and said beam synthesizing part so as to adjust positions of said optical beams on said surface to be scanned.

25. The optical scanning apparatus as claimed in claim 24, wherein said light path deflecting part is formed of a transmission type optical element that is eccentrically provided.

26. The optical scanning apparatus as claimed

in claim 24, wherein said light path deflecting part is formed of a liquid crystal element controllable by an electronic signal.

27. The optical scanning apparatus as claimed in claim 26, further comprising a ghost light removing part removing ghost light caused by said liquid crystal element, wherein said ghost light removing part is provided as a slit aperture between said liquid crystal element and said deflector.

28. The optical scanning apparatus as claimed in claim 27, further comprising an aperture shaping an optical beam, wherein said aperture is provided in an upper stream side, that is, an illuminant side, of said light path deflecting part and the following formula is satisfied;

$$L \geq (b + \Delta)/(2 \times \tan\theta),$$

where b is a width of optical beams deflected by said

liquid crystal element, Δ is a width of said slit aperture, L is a distance between said liquid crystal element and said slit aperture, and 2θ is an angle between +1st-order light and -1st-order light of said ghost light caused by said liquid crystal element.

29. The optical scanning apparatus as claimed in claim 24, further comprising an optical housing accommodating parts thereof, wherein said optical housing holds said illuminant apparatus on a side wall thereof and holds said light path deflecting part and said beam synthesizing part on a common holding part therein.

30. An image forming apparatus for forming an image, comprising:

an optical scanning apparatus for scanning a surface to be scanned in a main scanning direction by simultaneously using a plurality of optical spots formed

of a plurality of optical beams emitted from an illuminant comprising a light path deflecting part deflecting a light path of at least one of said optical beams, wherein said light path deflecting part is provided in light paths of said optical beams;

a photoreceptor forming an electrostatic latent image scanned by said optical scanning apparatus;

a developing apparatus developing said electrostatic latent image as a toner image with a toner; and

a transferring apparatus transferring said toner image in a recording medium.

31. An image forming apparatus for forming an image, comprising:

an optical scanning apparatus for scanning a surface to be scanned in a main scanning direction by simultaneously using a plurality of optical spots formed of a plurality of optical beams emitted from a plurality of illuminants in an illuminant apparatus wherein said illuminant apparatus comprises a plurality of light path deflecting parts, which is integrally provided therein,

deflecting one of said optical beams corresponding to each of said light path deflecting parts, comprising a detecting part detecting positions for simultaneously scanning said surface to be scanned and a driving part driving/controlling said light path deflecting parts based on a detection result of said detecting part so as to adjust a position of at least one of said optical spots;

a photoreceptor forming an electrostatic latent image scanned by said optical scanning apparatus;

a developing apparatus developing said electrostatic latent image as a toner image with a toner; and

a transferring apparatus transferring said toner image in a recording medium.

32. The image forming apparatus as claimed in claim 30, wherein said light path deflecting part is driven/controlled by an operator based on an output image on said recording medium.

33. The image forming apparatus as claimed in claim 30, further comprising a plurality of said photoreceptors serving as a plurality of surfaces to be scanned.

34. The image forming apparatus as claimed in claim 30, further comprising a plurality of said optical scanning apparatuses wherein said optical scanning apparatuses are aligned in line in the main scanning direction for said photoreceptor.

35. The image forming apparatus as claimed in claim 30, wherein said image has variable pixel density.

36. An optical scanning apparatus for scanning a surface to be scanned by using a beam spot formed of an optical beam emitted from a semiconductor laser, comprising:

a liquid crystal element deflecting a light path of said optical beam on said surface to be scanned; and

a light rotating part rotating a polarization plane of said optical beam.

37. The optical scanning apparatus as claimed in claim 36, wherein said light rotating part is formed of a 1/2 wavelength plate.

38. The optical scanning apparatus as claimed in claim 37, wherein said 1/2 wavelength plate is held by a rotation adjusting part and is capable of rotating upon an optical axis.

39. The optical scanning apparatus as claimed in claim 36, wherein a position of said optical spot is adjusted on the surface to be scanned by deflecting a light path of said optical beam in a subscanning section of said liquid crystal element.

40. The optical scanning apparatus as claimed in claim 36, wherein said semiconductor laser is formed of a semiconductor laser array having a plurality of illuminant points.

41. The optical scanning apparatus as claimed in claim 40, wherein said semiconductor laser array is inclined toward an optical axis of said optical beam emitted.

42. The optical scanning apparatus as claimed in claim 39, wherein said surface to be scanned is scanned by an optical beam synthesized from at least two optical beams emitted from at least two semiconductor lasers by using a PBS (Polarization Beam Splitter) surface, and said liquid crystal element is arranged so as to convert an optical beam emitted from said liquid crystal element into one of an S-polarized optical beam or a P-polarized optical beam toward said PBS surface.

43. The optical scanning apparatus as claimed in claim 39, wherein said surface to be scanned is scanned by an optical beam synthesized from at least two optical beams emitted from at least two semiconductor lasers by using a half-mirror.

44. An image forming apparatus for forming an image, comprising:

an optical scanning apparatus for scanning a surface to be scanned by using an optical spot formed of an optical beam emitted from a semiconductor laser, the optical scanning apparatus comprising a liquid crystal element deflecting a light path of said optical beam on said surface to be scanned and a light rotating part rotating a polarization plane of said optical beam;

a photoreceptor forming an electrostatic latent image scanned by said optical scanning apparatus;

a developing part developing said electrostatic latent image as a toner image with a toner; and

a transferring part transferring said toner image in a recording medium.

45. The image forming apparatus as claimed in claim 44, wherein said optical scanning apparatus scans said photoreceptor by using a plurality of beam spots formed of a plurality of optical beams and is capable of adjusting a scanning line pitch on said photoreceptor.

46. The image forming apparatus as claimed in claim 44, wherein said optical scanning apparatus scans said photoreceptor by using a plurality of optical beams and is capable of switching a pixel density of the image.

47. A tandem type image forming apparatus for forming an image, comprising:

an optical scanning apparatus for scanning a surface to be scanned by using a beam spot formed of an optical beam emitted from a semiconductor laser, the optical scanning apparatus comprising a liquid crystal element deflecting a light path of said optical beam on said surface to be scanned; and a light rotating part rotating a polarization plane of said optical beam;

a photoreceptor forming an electrostatic latent image scanned by said optical scanning apparatus;

a developing part developing said electrostatic latent image as a toner image with a

toner; and

a transferring part transferring said toner image in a recording medium,

wherein a plurality of said photoreceptors are provided, said optical scanning apparatus scans said photoreceptors with a plurality of optical beams, and misalignment of a write start position between said photoreceptors is corrected.

48. A division scanning type image forming apparatus for forming an image, comprising:

an optical scanning apparatus for scanning a surface to be scanned by using a beam spot formed of an optical beam emitted from a semiconductor laser, the optical scanning apparatus comprising a liquid crystal element deflecting a light path of said optical beam on said surface to be scanned and a light rotating part rotating a polarization plane of said optical beam;

a photoreceptor forming an electrostatic latent image scanned by said optical scanning apparatus;

a developing part developing said electrostatic latent image as a toner image with a

toner; and

a transferring part transferring said toner image in a recording medium,

wherein a plurality of said optical scanning apparatuses are aligned in line with respect to a main scanning direction for each photoreceptor and misalignment of said beam spot with respect to a main scanning direction around a connection area between scanning beams from said optical scanning apparatuses is corrected.

49. The division scanning type image forming apparatus as claimed in claim 48, wherein said misalignment of the beam spot around a connection area between scanning beams is corrected with respect to a subscanning direction.

ABSTRACT OF THE DISCLOSURE

An optical scanning apparatus scans a surface to be scanned in a main scanning direction by simultaneously using a plurality of optical spots formed of a plurality of optical beams emitted from an illuminant, comprising: a light path deflecting part deflecting a light path of at least one of the optical beams, wherein the light path deflecting part is provided in light paths of the optical beams wherein the light path deflecting part may use a liquid crystal deflecting element formed of a liquid crystal element being controllable by an electronic signal to deflect the light path of the one of the optical beams.

FIG. 1

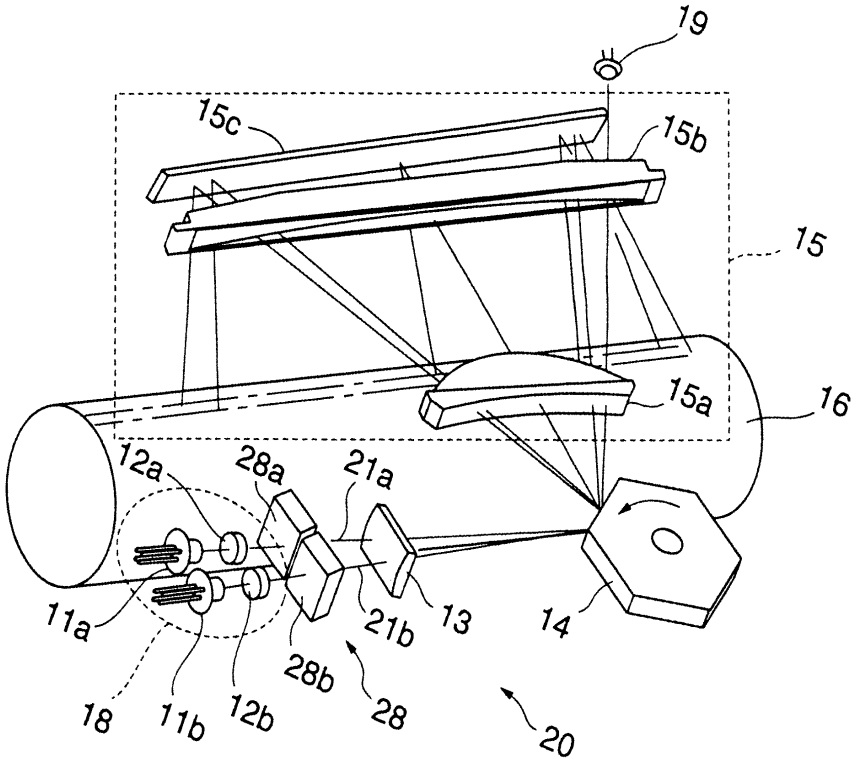


FIG. 2

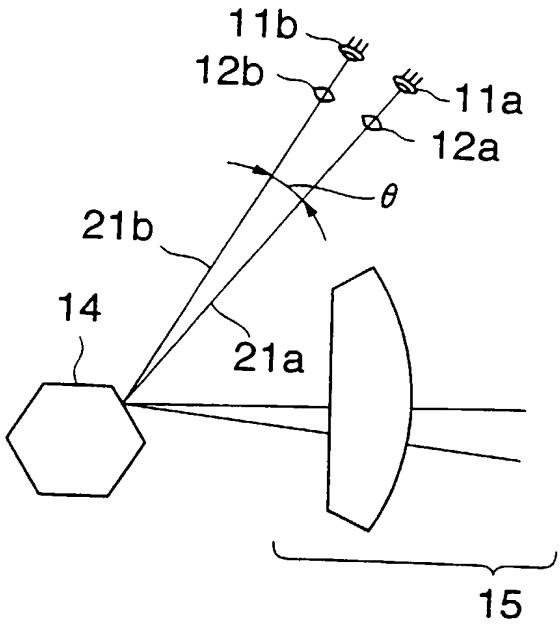


FIG. 3

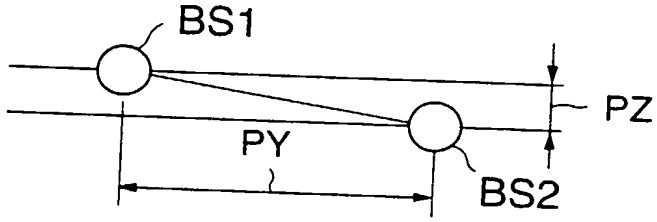


FIG. 4

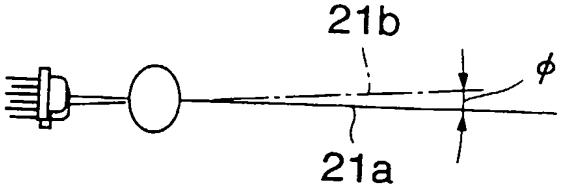


FIG. 5A

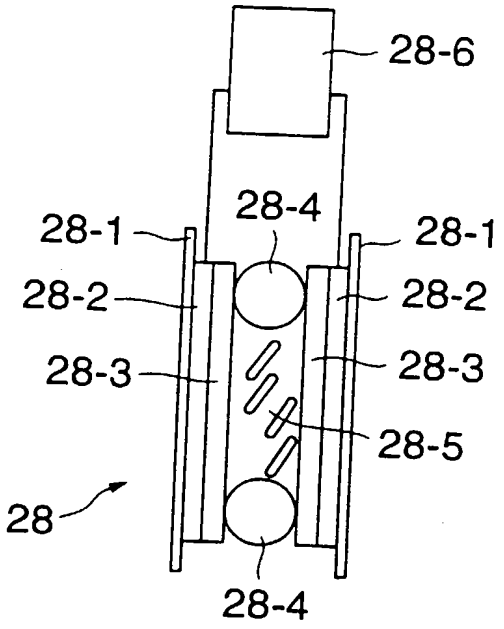


FIG. 5B

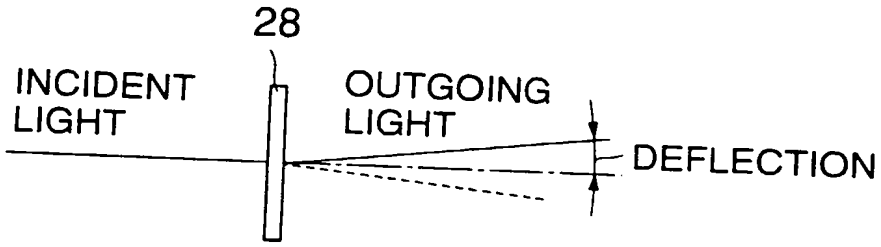


FIG. 6

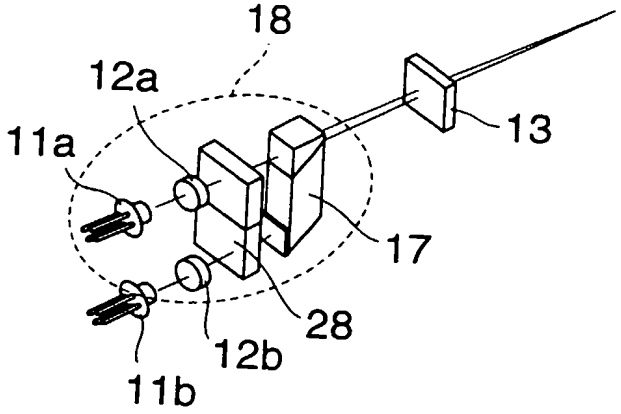


FIG. 7A FIG. 7B FIG. 7C

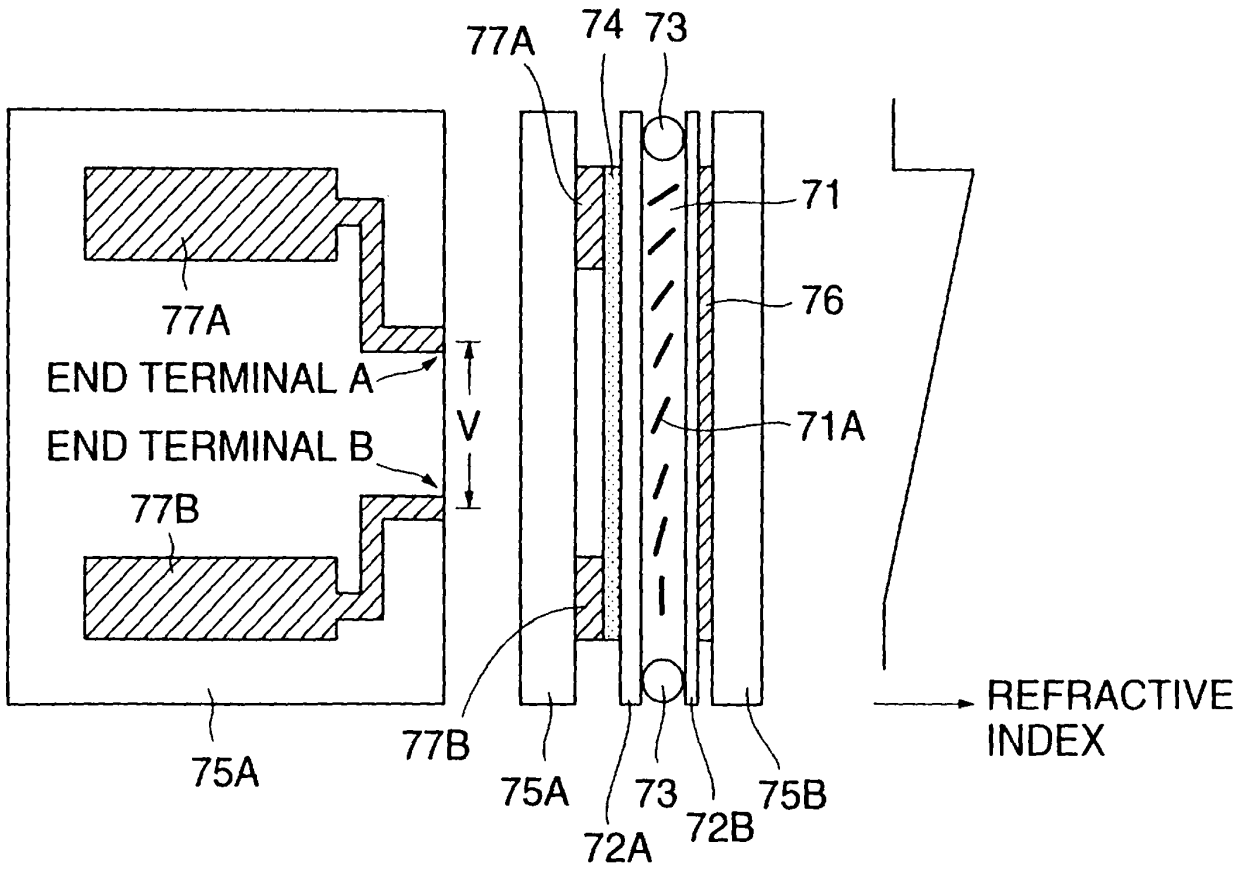


FIG. 8A

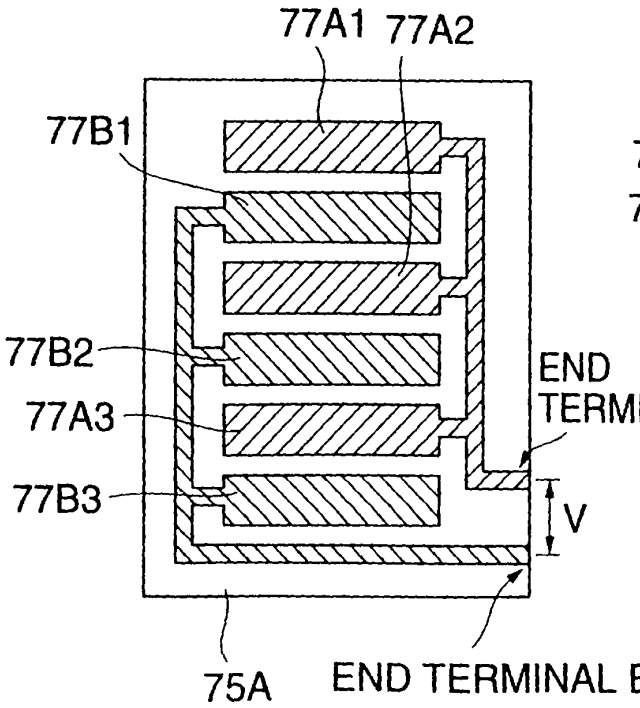


FIG. 8B

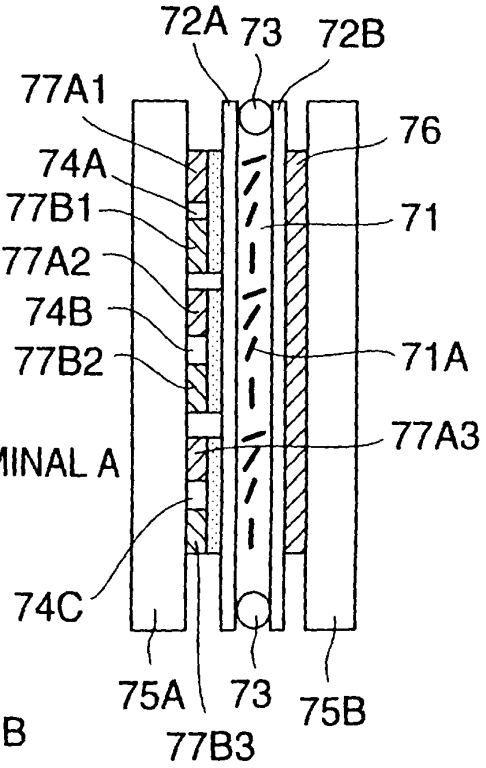


FIG. 8C

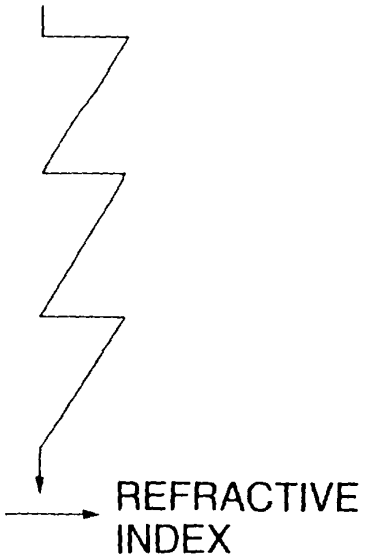


FIG. 9A

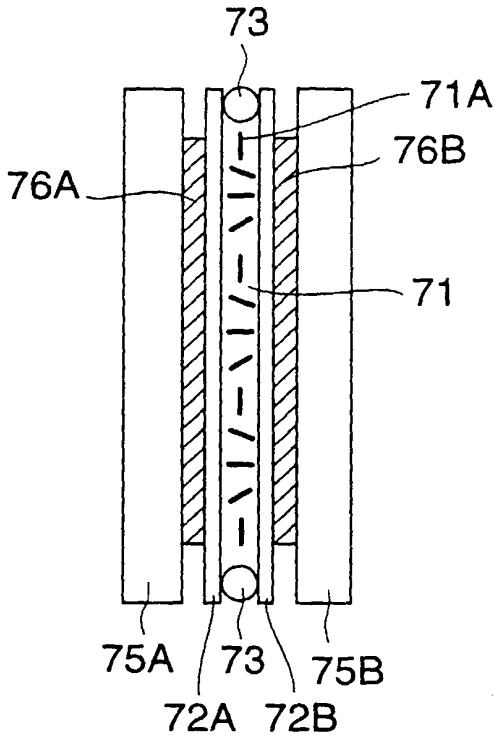


FIG. 9B

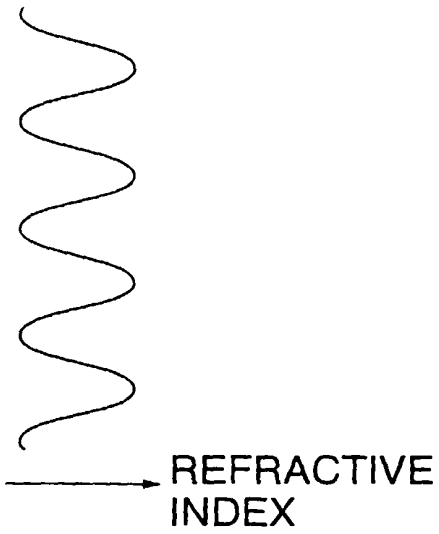


FIG. 10

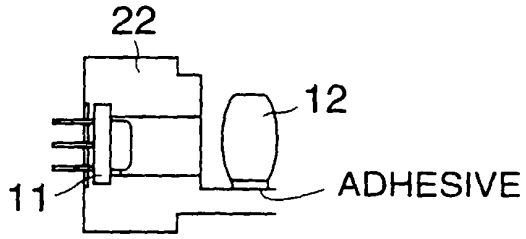


FIG. 11

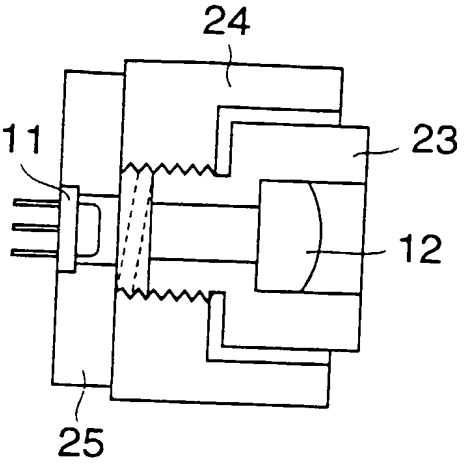


FIG. 12

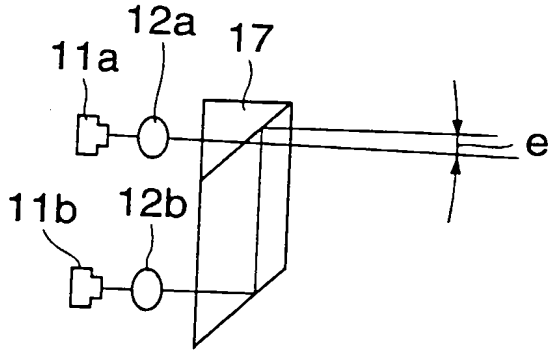


FIG. 13

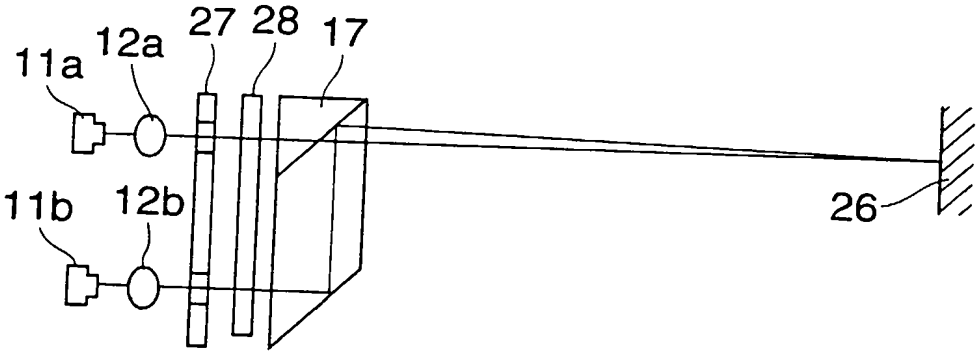


FIG. 14

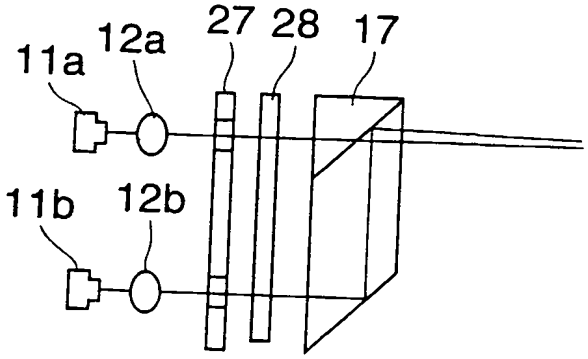


FIG. 15

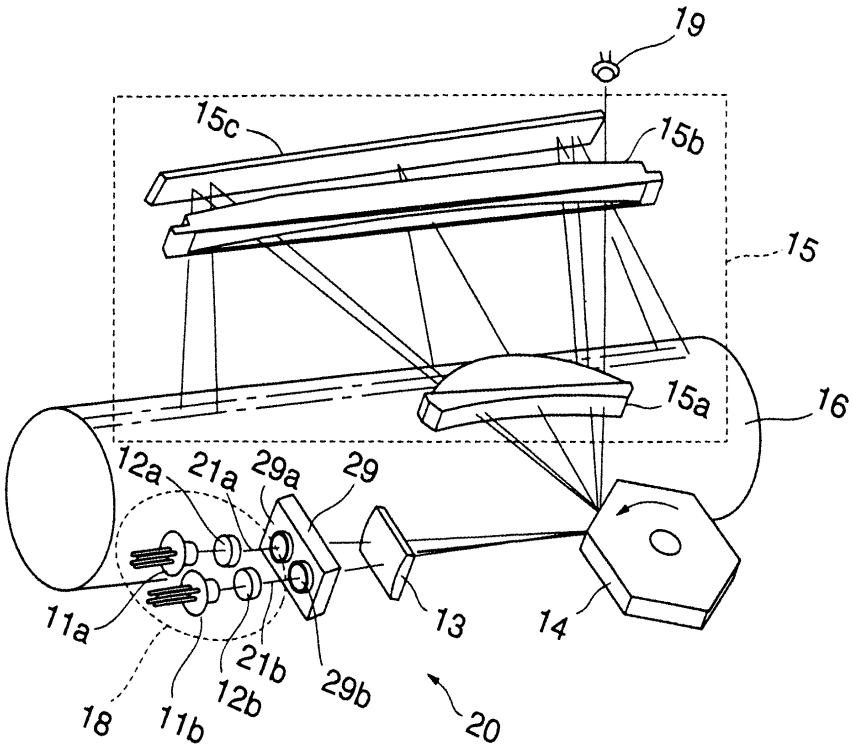


FIG. 16

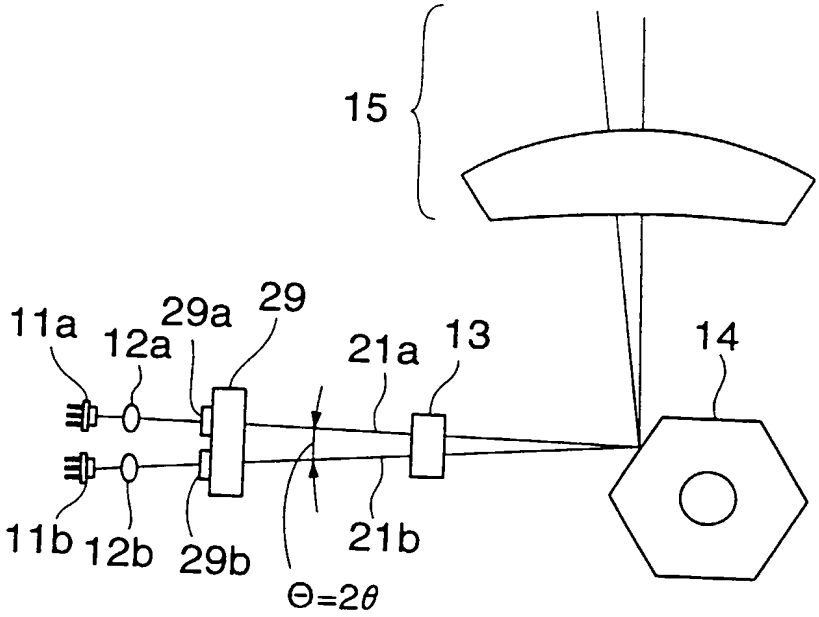


FIG. 17

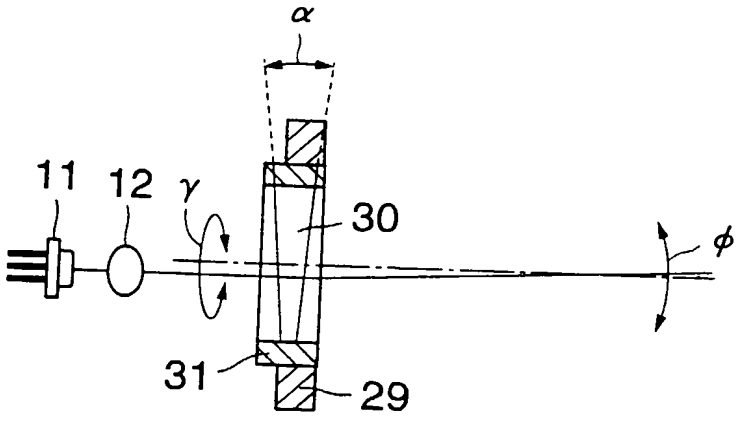


FIG. 18A

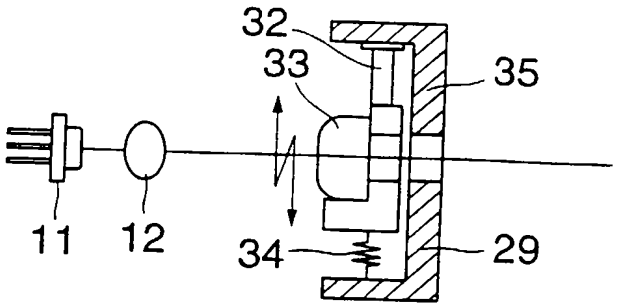


FIG. 18B

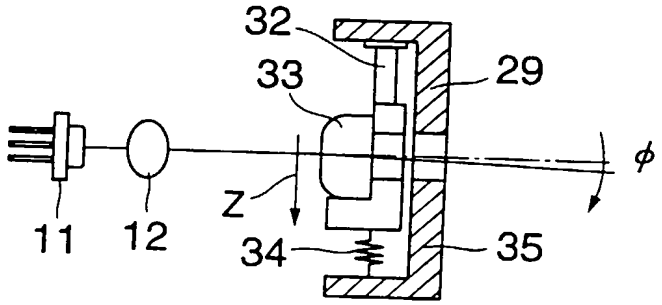


FIG. 18C

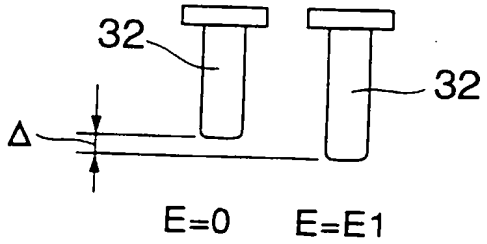


FIG. 19A

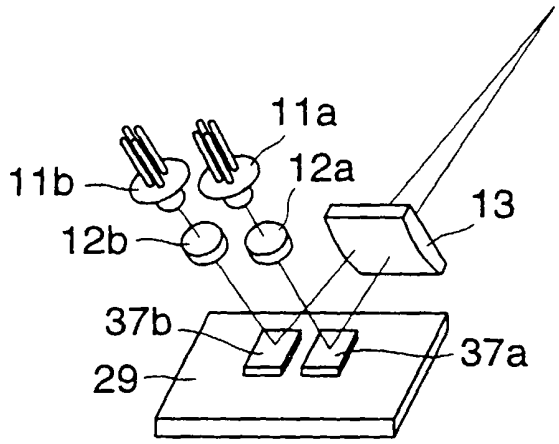


FIG. 19B

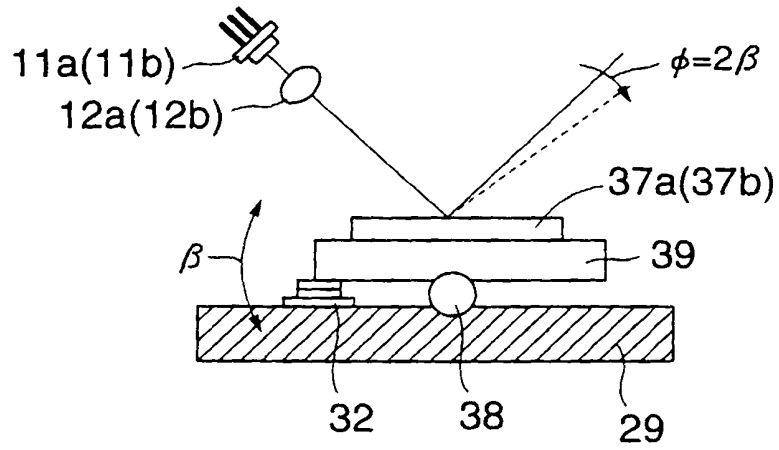


FIG. 20A

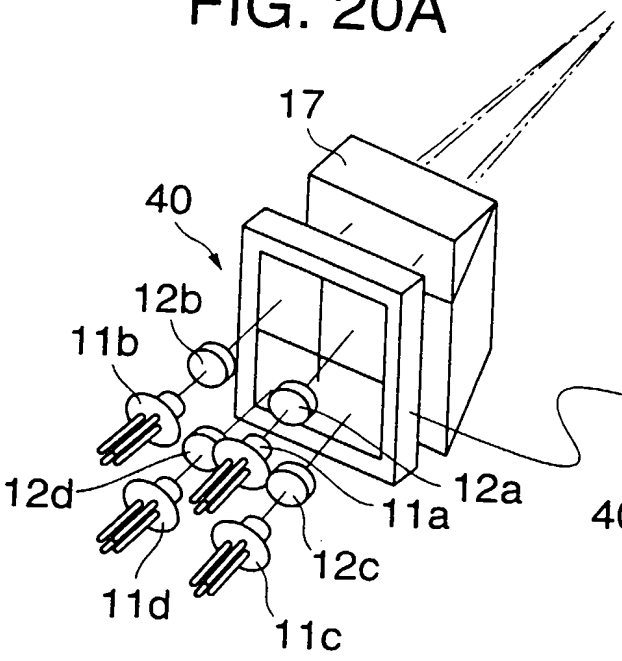


FIG. 20B

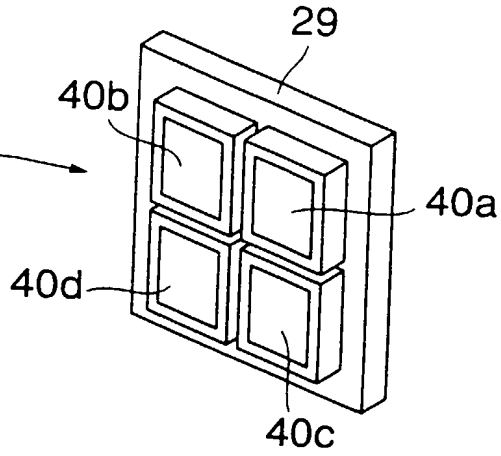


FIG. 21

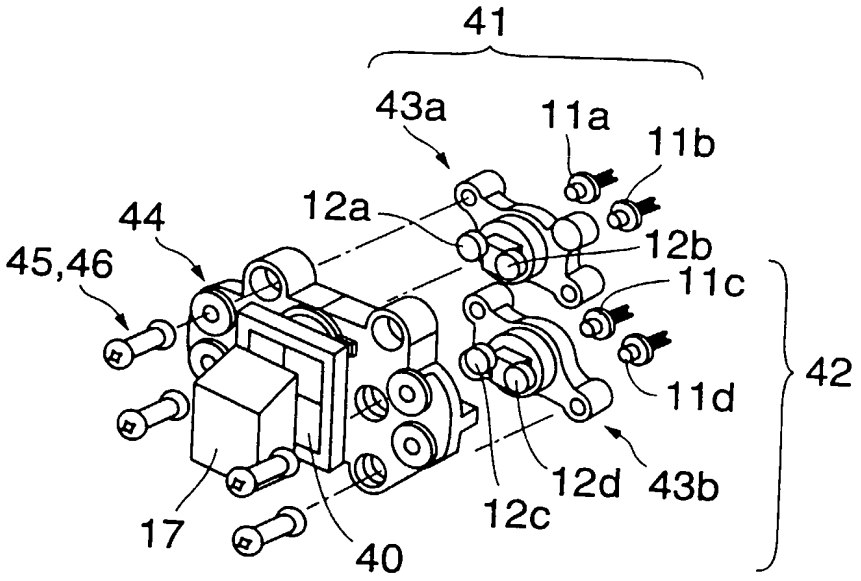


FIG. 22A

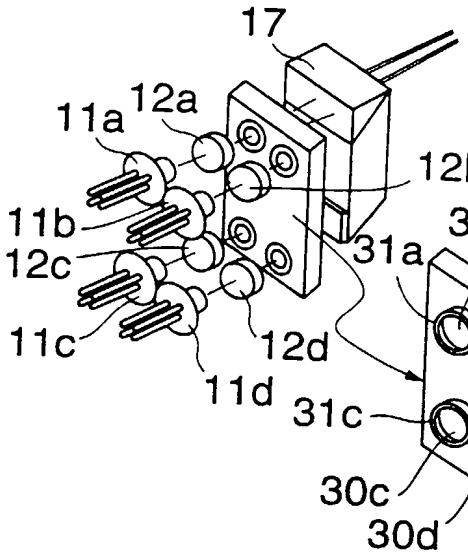


FIG. 22B

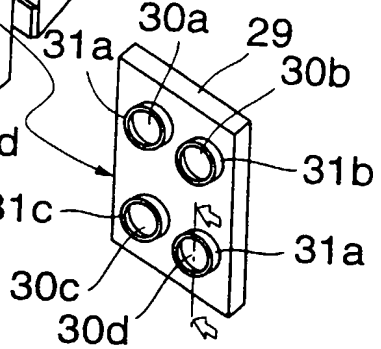


FIG. 23A

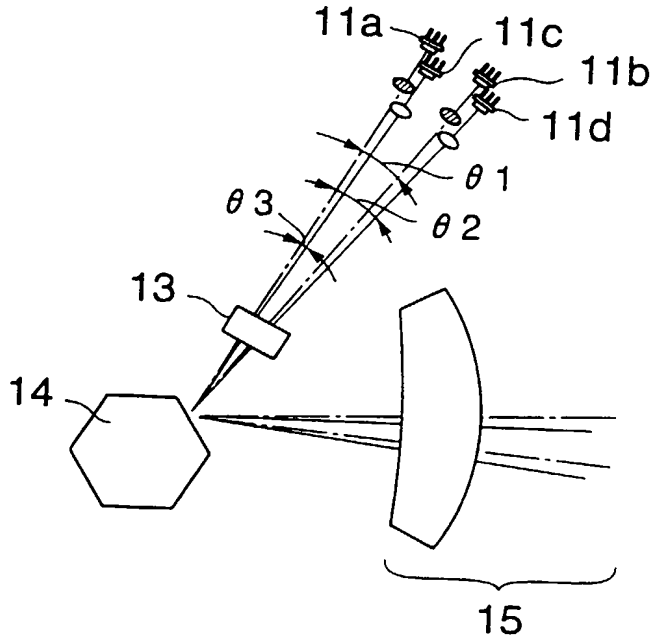


FIG. 23B

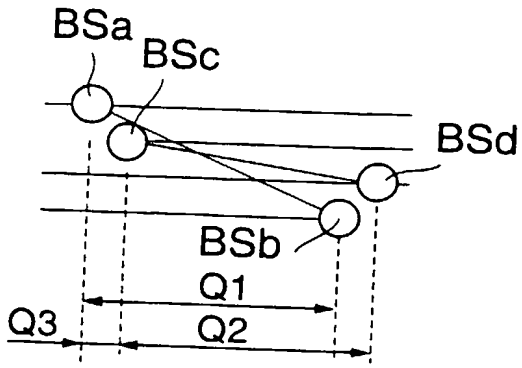


FIG. 24

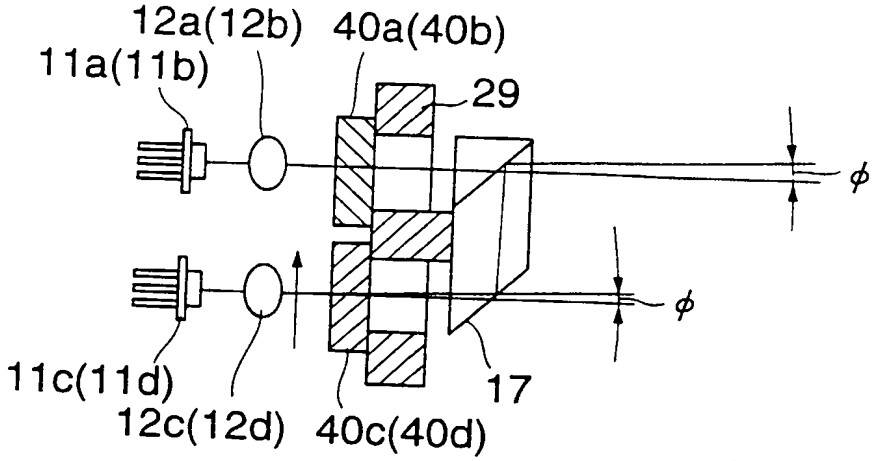


FIG. 25

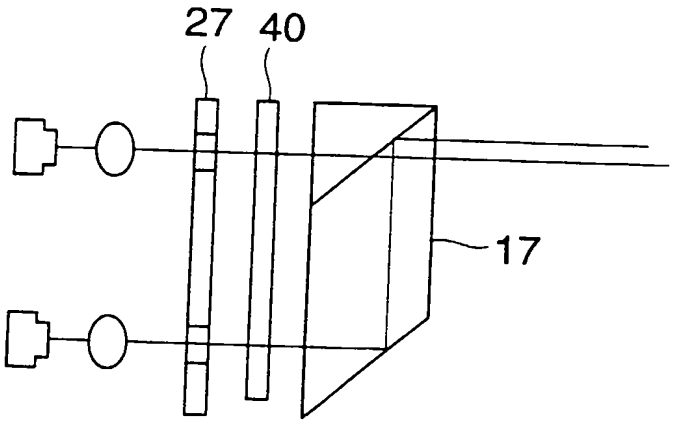


FIG. 26A

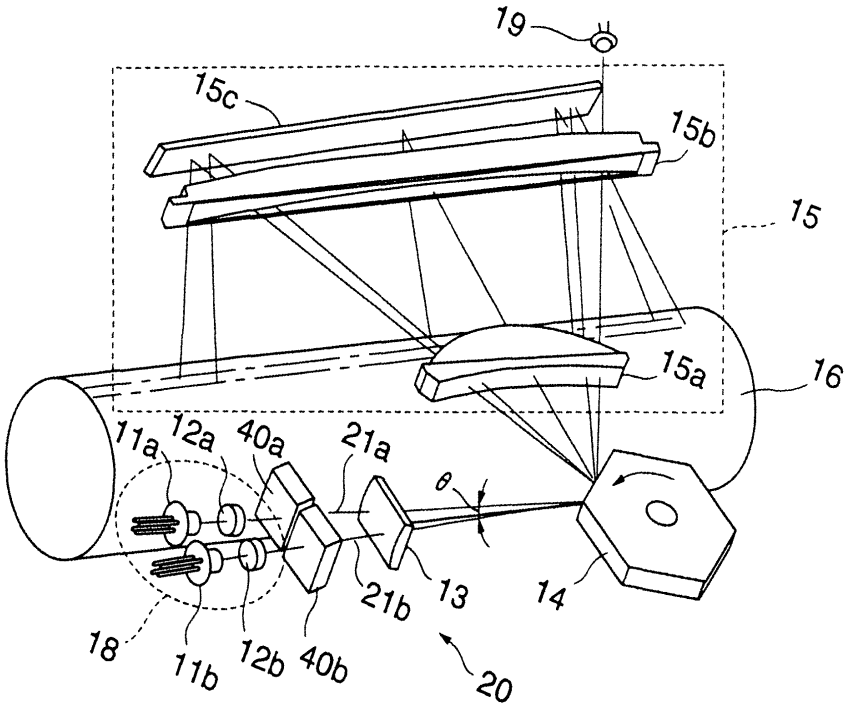


FIG. 26B

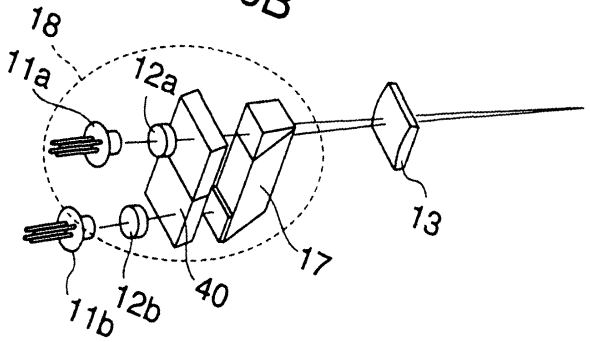


FIG. 27

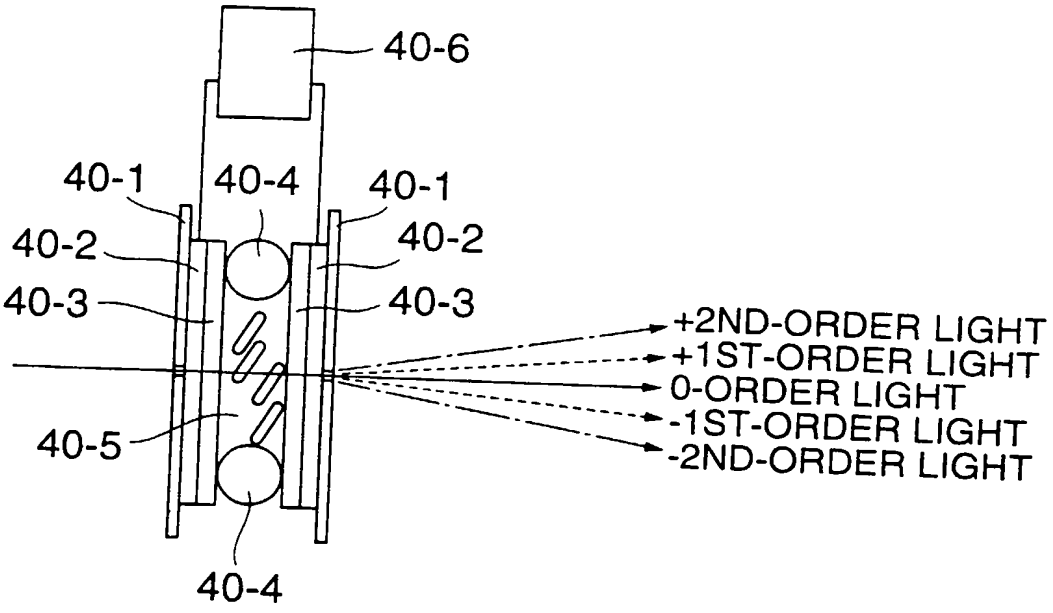

40-6
40-1
40-4
40-1
40-2
40-2
40-3
40-3
+2ND-ORDER LIGHT
+1ST-ORDER LIGHT
0-ORDER LIGHT
-1ST-ORDER LIGHT
-2ND-ORDER LIGHT
40-5
40-4

FIG. 28

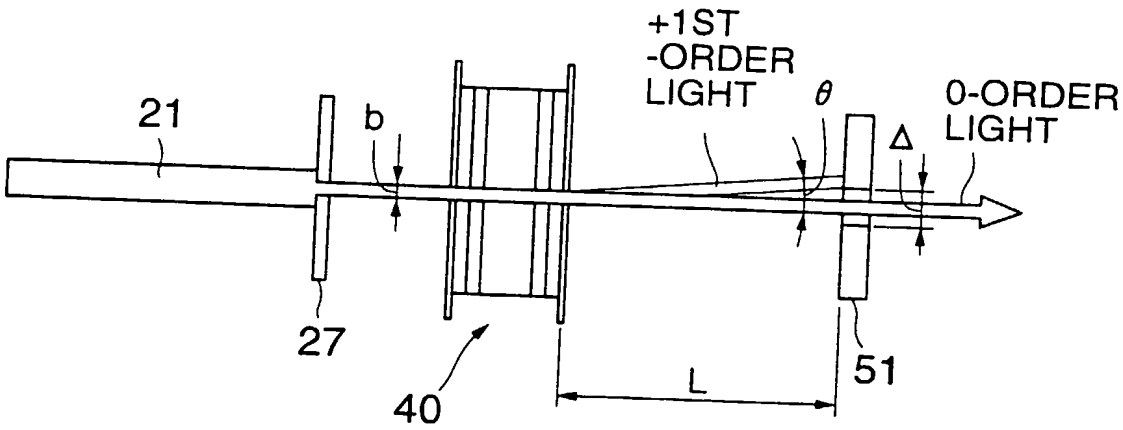

+1ST
-ORDER
LIGHT
θ
0-ORDER
LIGHT
21
b
Δ
27
40
L
51

FIG. 29A

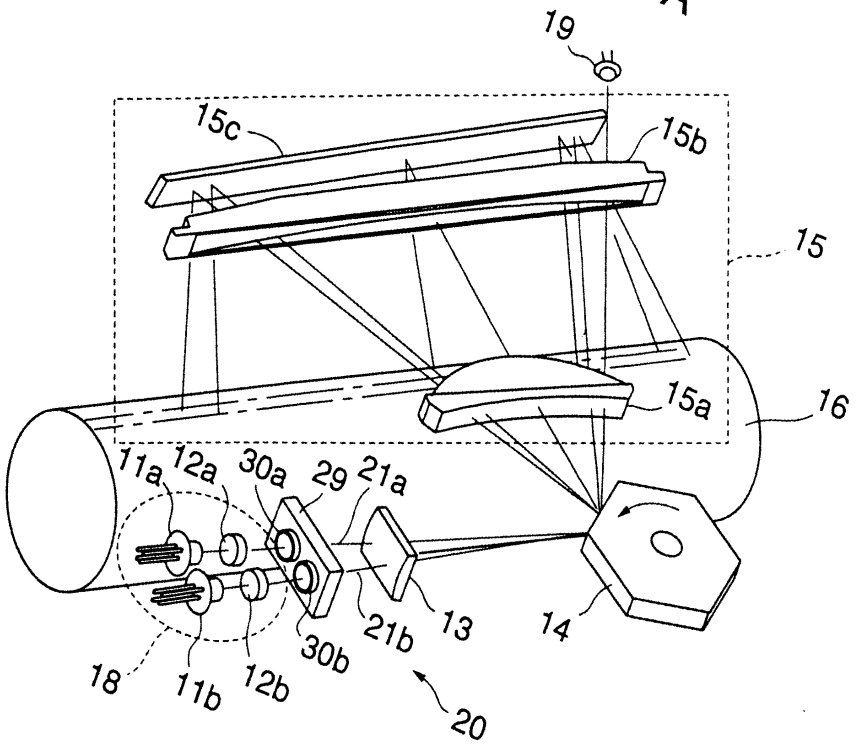


FIG. 29B

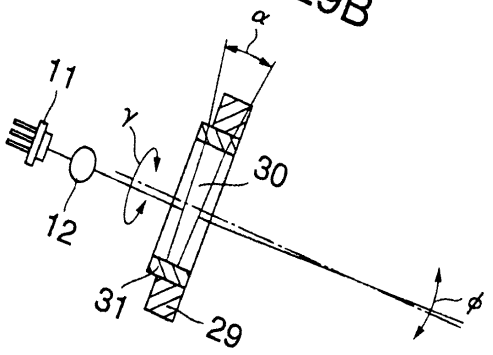


FIG. 30

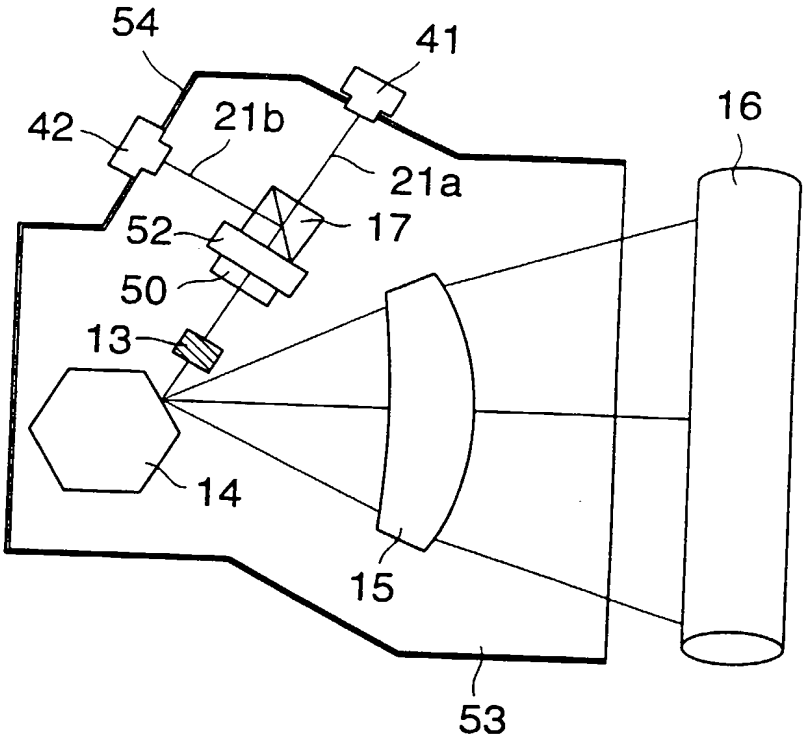


FIG. 31A

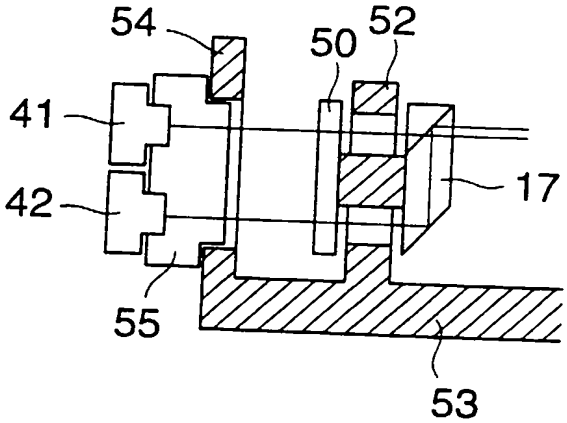


FIG. 31B

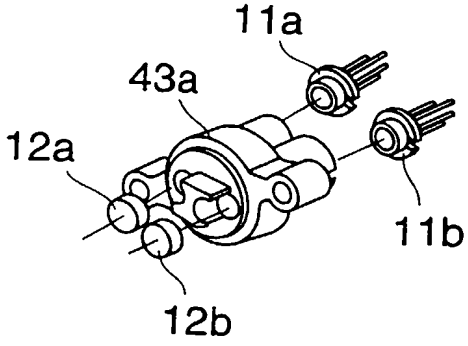


FIG. 32

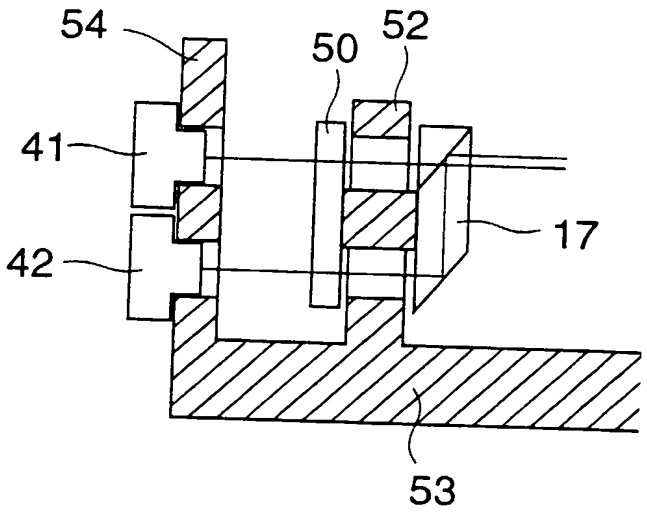


FIG. 33A

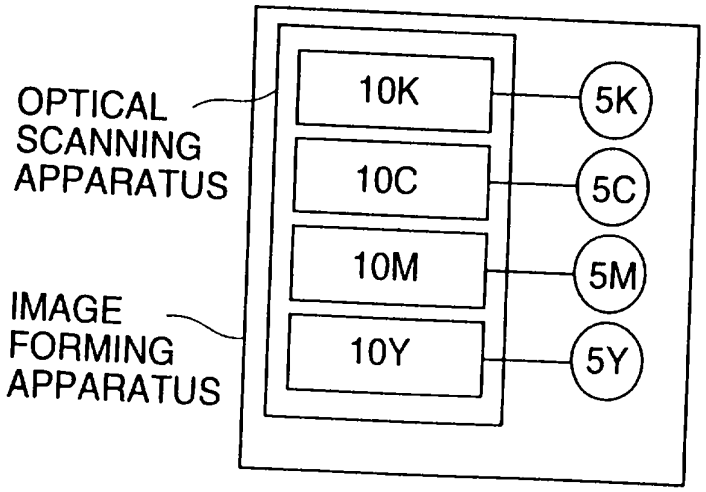


FIG. 33B

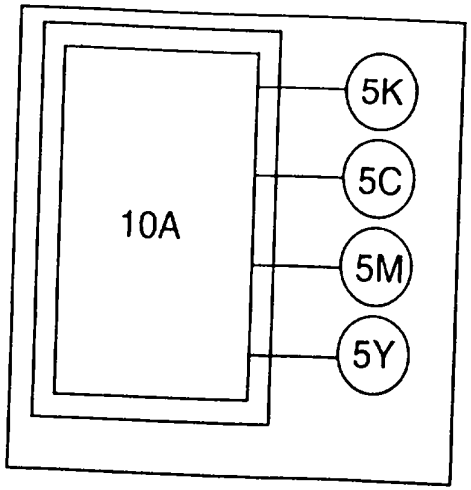


FIG. 33C

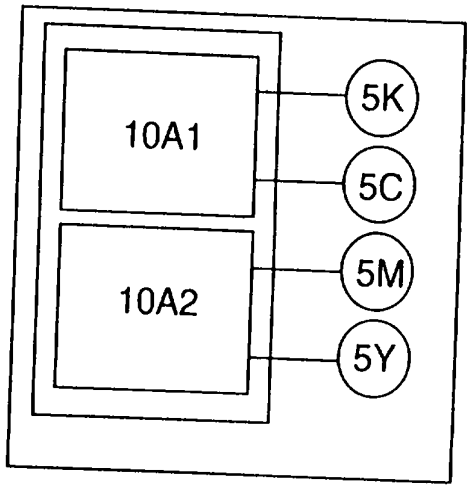


FIG. 33D

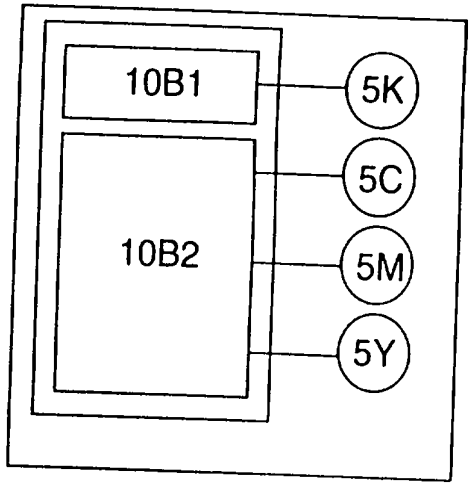


FIG. 34

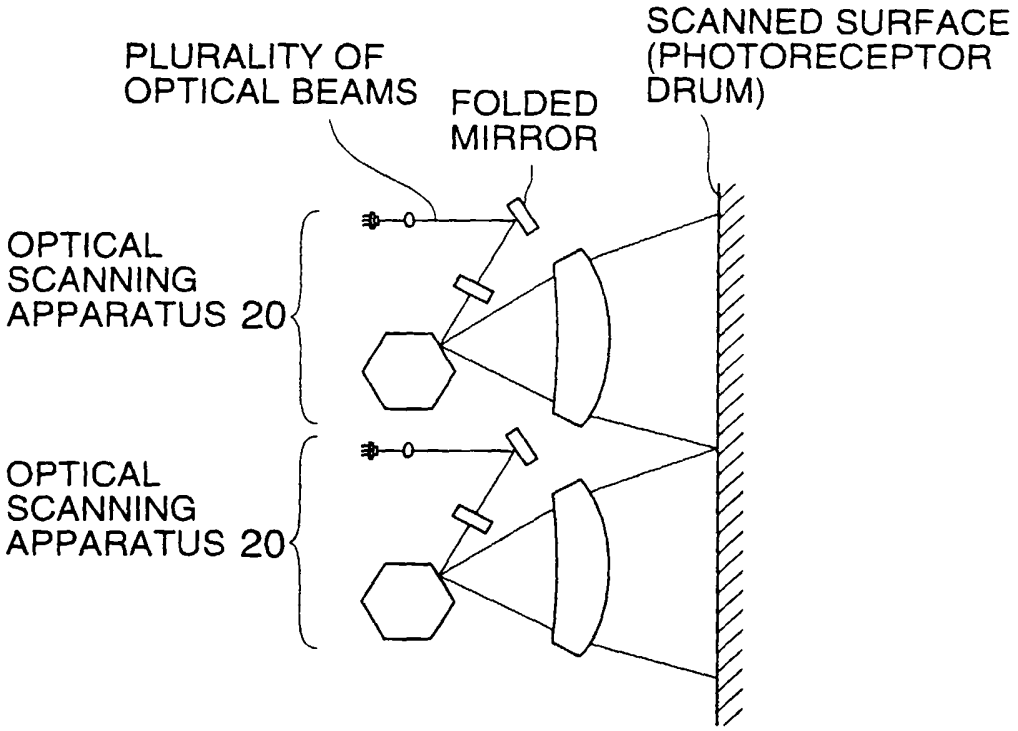

PLURALITY OF OPTICAL BEAMS
FOLDED MIRROR
SCANNED SURFACE (PHOTORECEPTOR DRUM)
OPTICAL SCANNING APPARATUS 20
OPTICAL SCANNING APPARATUS 20

FIG. 35

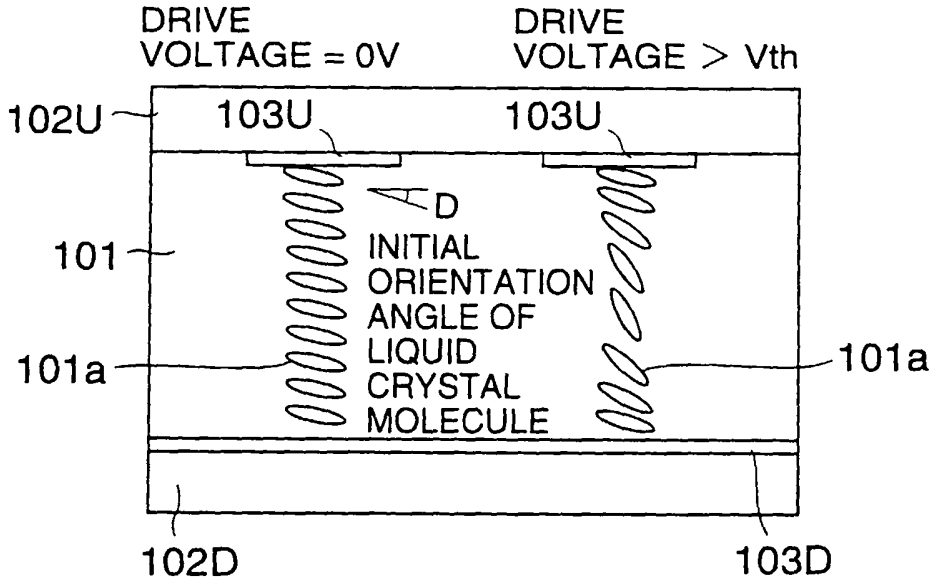

DRIVE VOLTAGE = 0V
DRIVE VOLTAGE > Vth
102U
103U
103U
D
101
INITIAL ORIENTATION ANGLE OF LIQUID CRYSTAL MOLECULE
101a
101a
102D
103D

FIG. 36

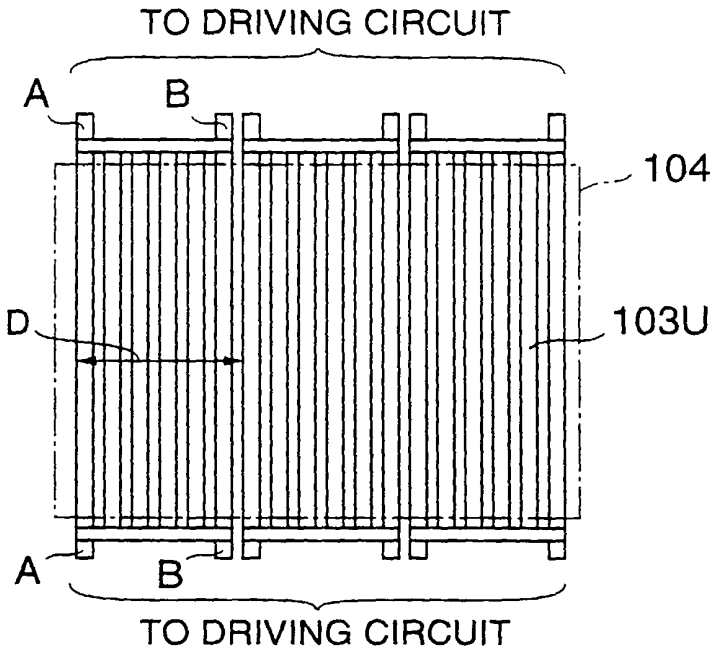

TO DRIVING CIRCUIT
A
B
104
D
103U
A
B
TO DRIVING CIRCUIT

FIG. 37

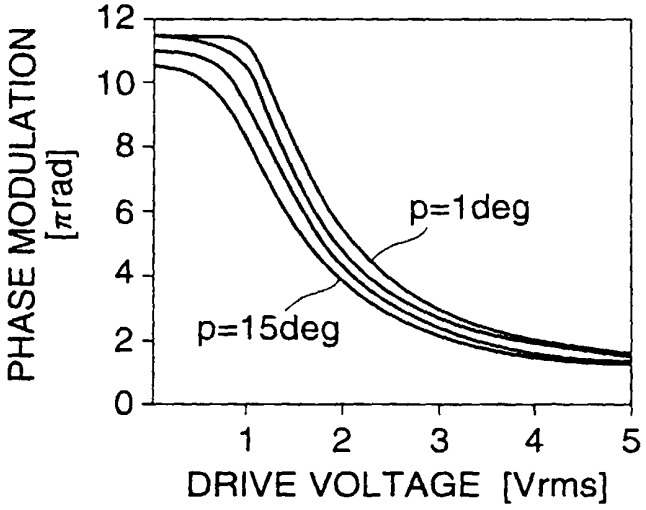

PHASE MODULATION [πrad]
12
10
8
6
4
2
0
p=1deg
p=15deg
1
2
3
4
5
DRIVE VOLTAGE [Vrms]

FIG. 38

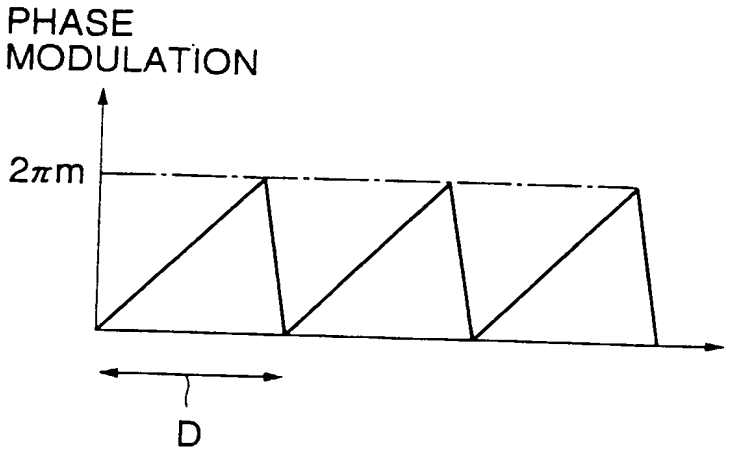

PHASE
MODULATION
2πm
D

FIG. 39

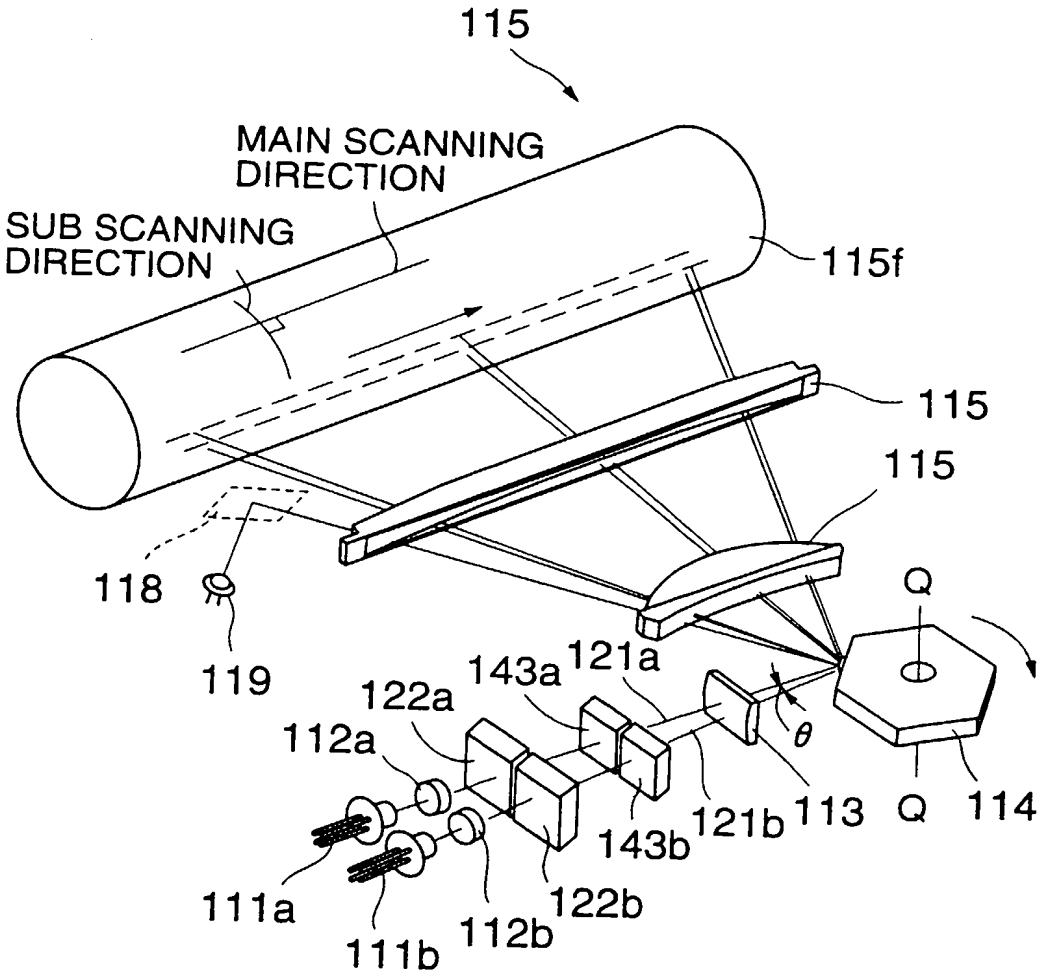

115
MAIN SCANNING
DIRECTION
SUB SCANNING
DIRECTION
115f
115
115
118
119
Q
143a
121a
122a
112a
θ
111a
111b
112b
122b
143b
121b
113
Q
114

FIG. 40

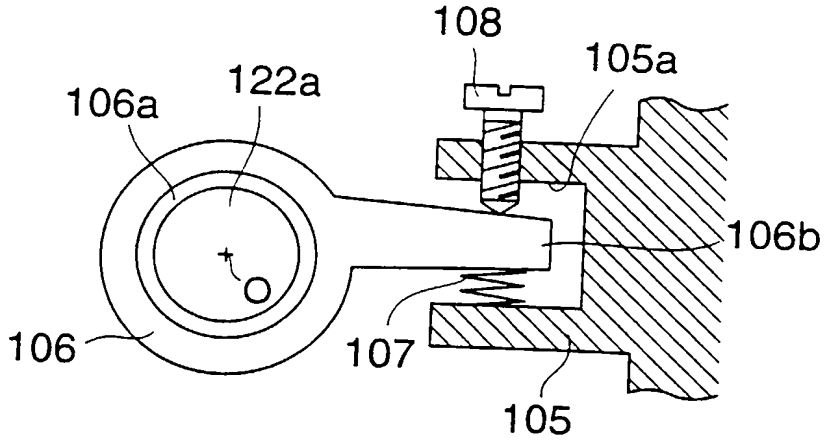


FIG. 41

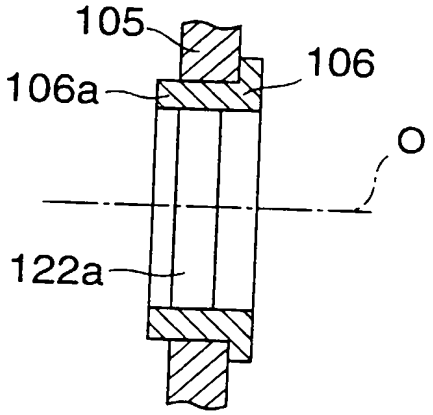


FIG. 42

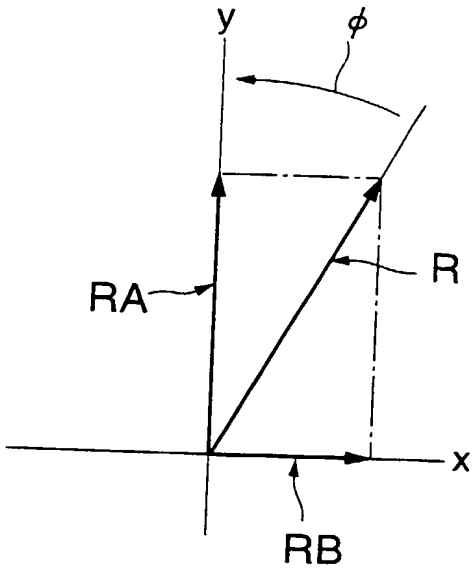


FIG. 43

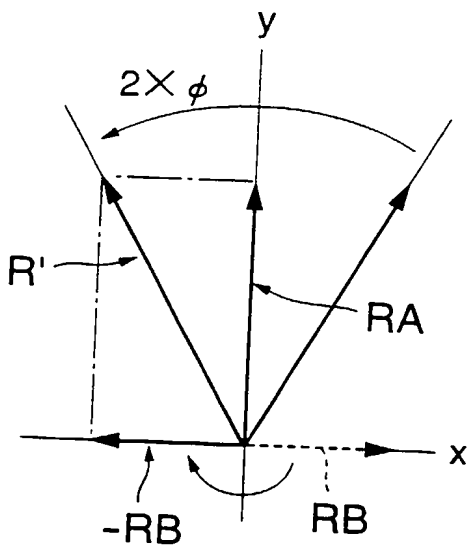

y
2X φ
R'
RA
x
-RB
RB

FIG. 44

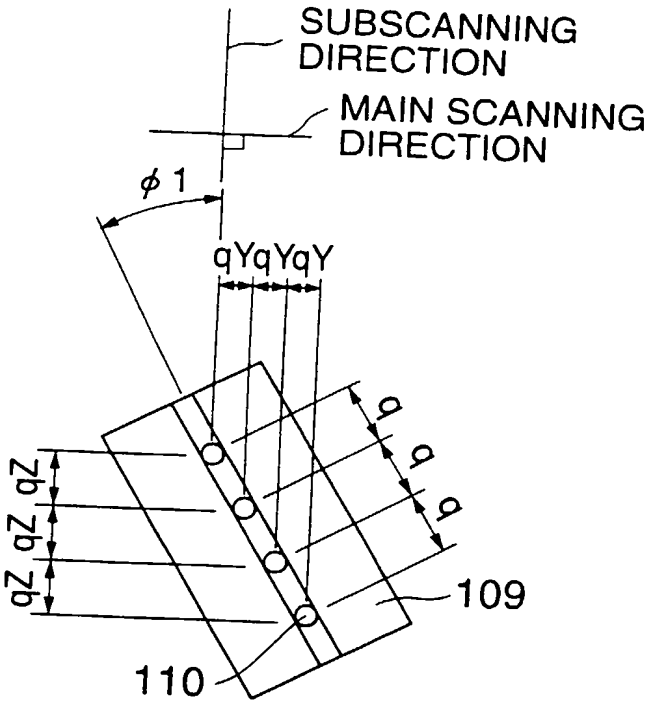

SUBSCANNING DIRECTION
MAIN SCANNING DIRECTION
φ1
qYqYqY
q
q
q
Zb
Zb
Zb
109
110

FIG. 45

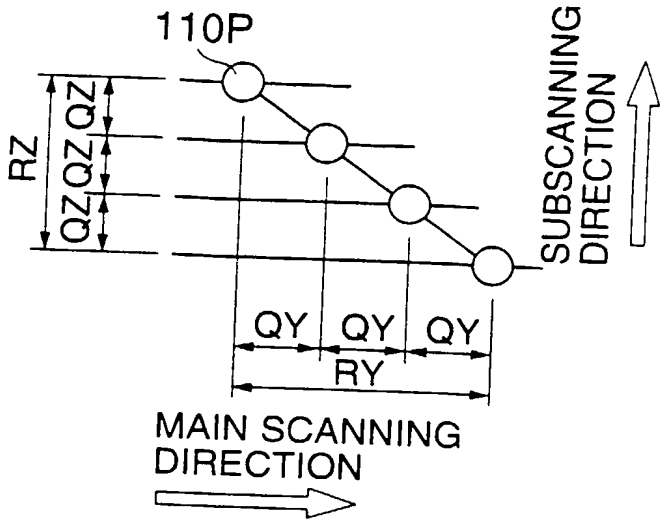


FIG. 46

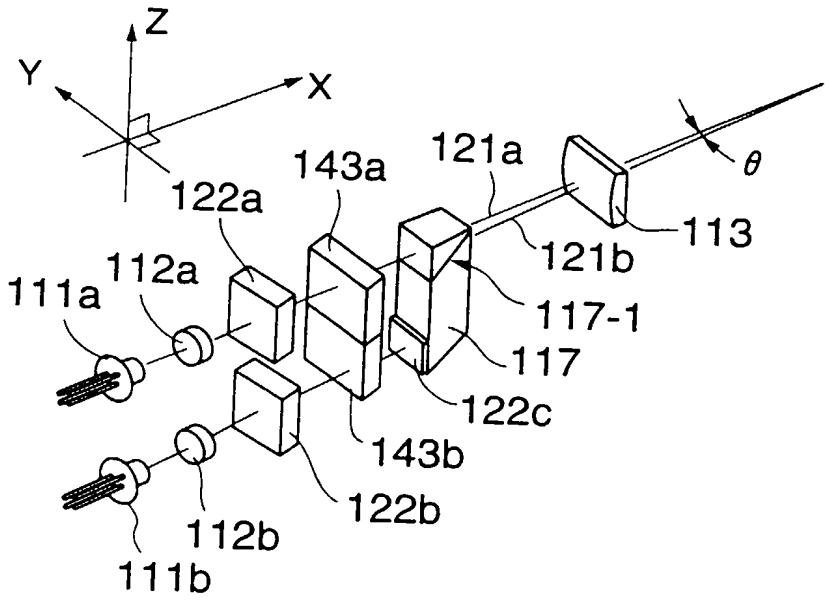


FIG. 47

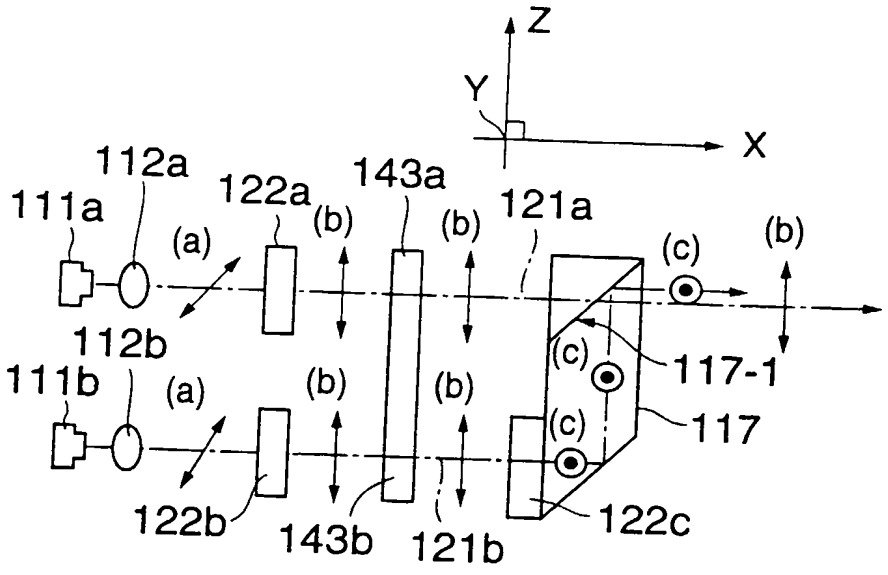


FIG. 48

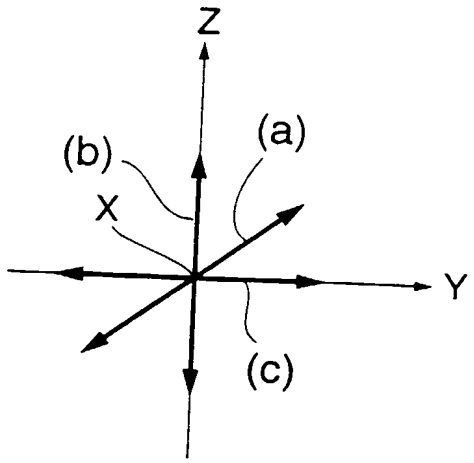

Z
(b)
(a)
X
Y
(c)

FIG. 49

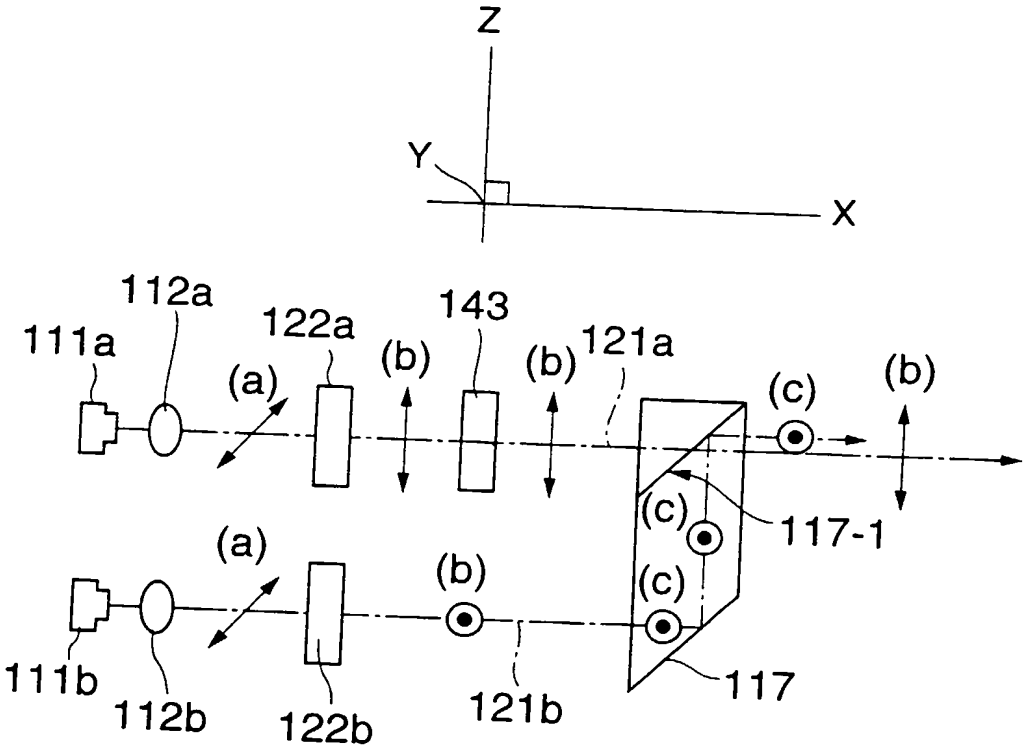

Z
Y
X
112a
111a
122a
143
(b)
(b)
121a
(a)
(c)
(b)
(c)
117-1
(a)
(b)
(c)
111b
112b
122b
121b
117

FIG. 50

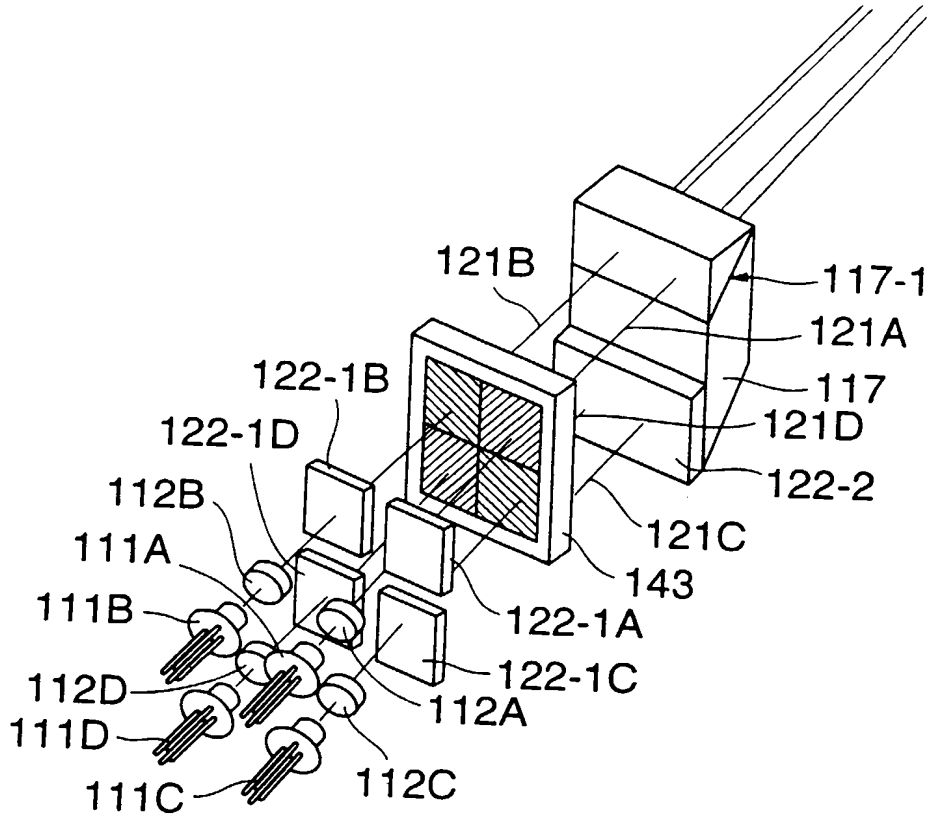

121B
117-1
121A
122-1B
117
122-1D
121D
122-2
112B
121C
111A
143
111B
122-1A
122-1C
112D
112A
111D
112C
111C

FIG. 51

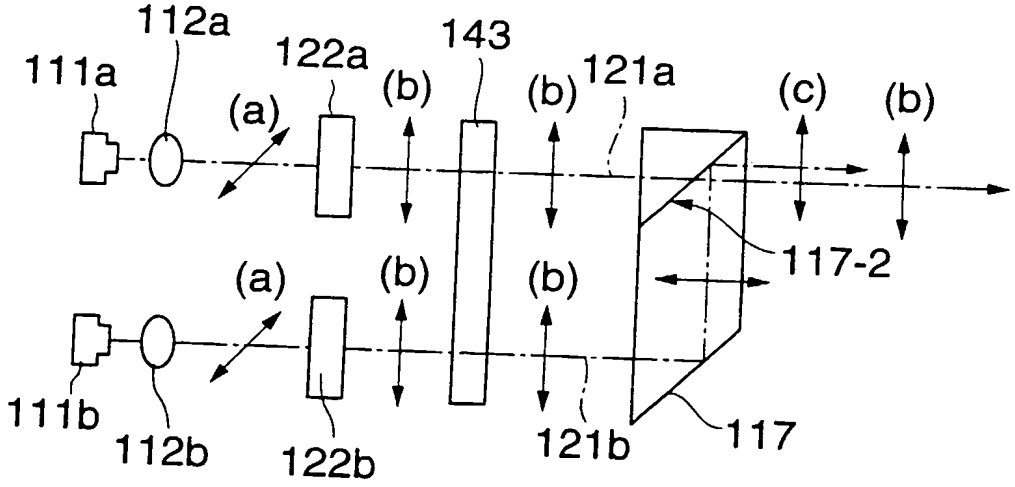

112a
143
111a
122a
(b)
(b)
121a
(c)
(b)
(a)
117-2
(a)
(b)
(b)
111b
112b
122b
121b
117

FIG. 52

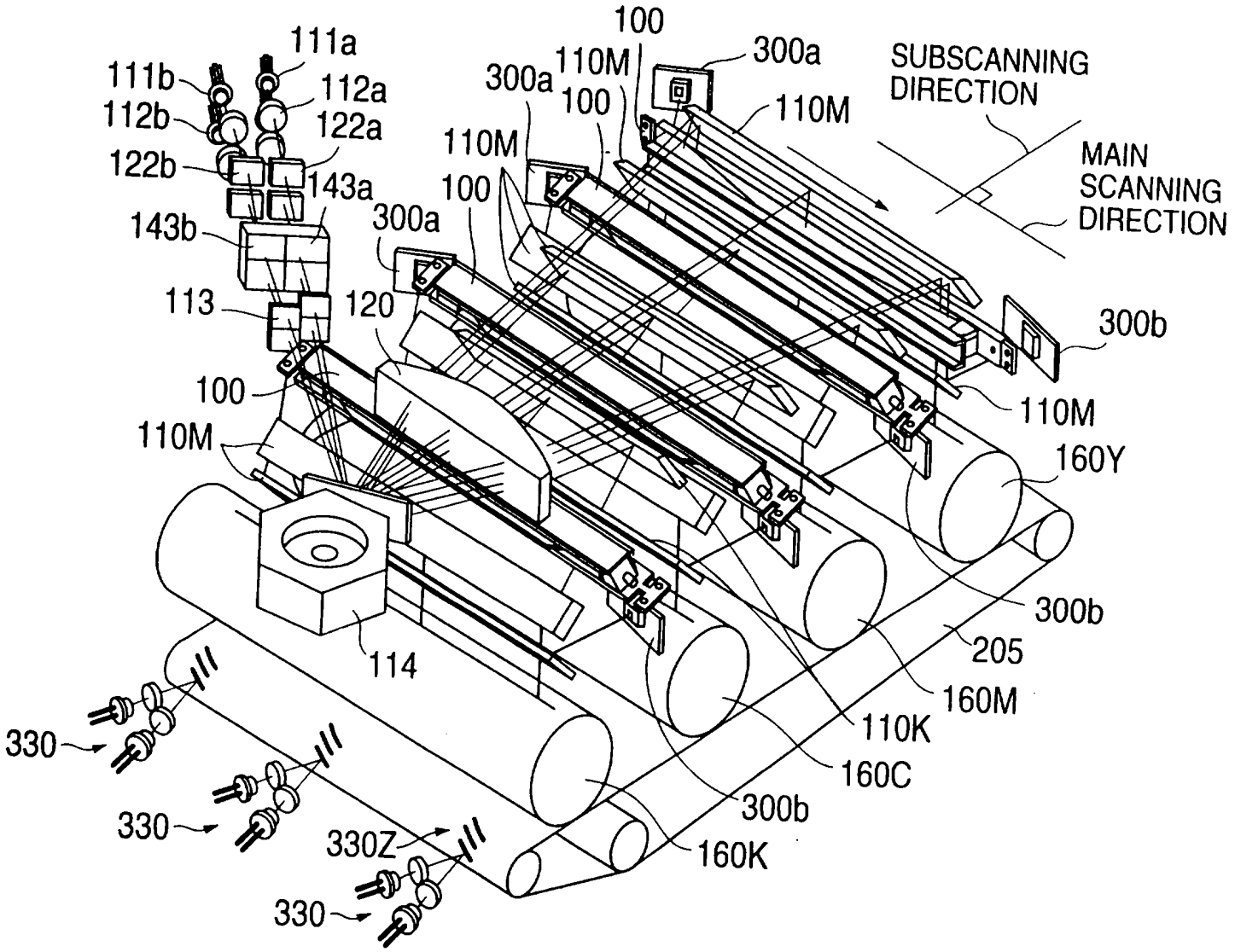
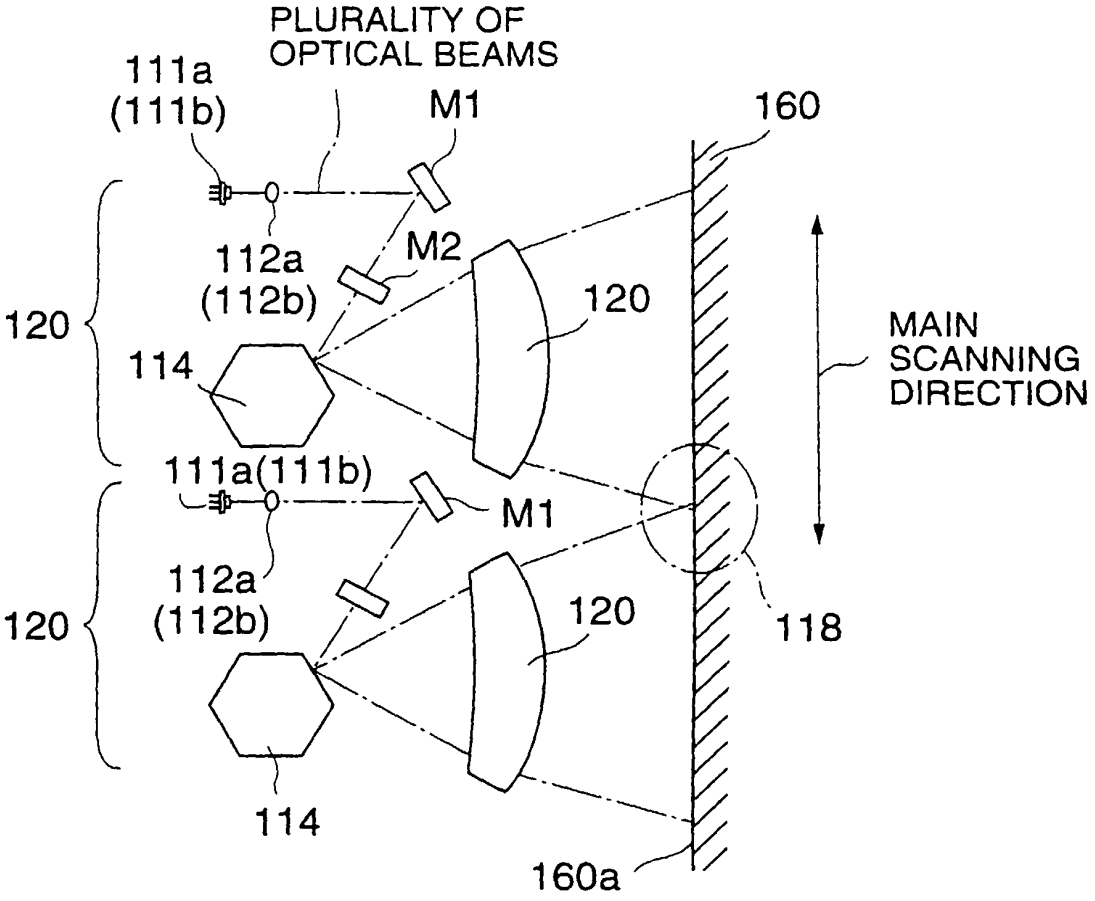

111a
111b
112a
112b
122a
122b
143a
143b
113
120
100
110M
300a
300b
SUBSCANNING DIRECTION
MAIN SCANNING DIRECTION
160Y
160M
160C
160K
110K
205
114
330
330Z

FIG. 53


PLURALITY OF
OPTICAL BEAMS
111a
(111b)
M1
160
112a
(112b)
M2
120
120
114
MAIN
SCANNING
DIRECTION
111a(111b)
M1
112a
(112b)
120
120
118
114
160a